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SOLAR/1043-79/04

Monthly Performance Report

HULLCO CONSTRUCTION

APRIL 1979

U.S. Department of Energy

National Solar Heating and Cooling Demonstration Program

National Solar Data Program

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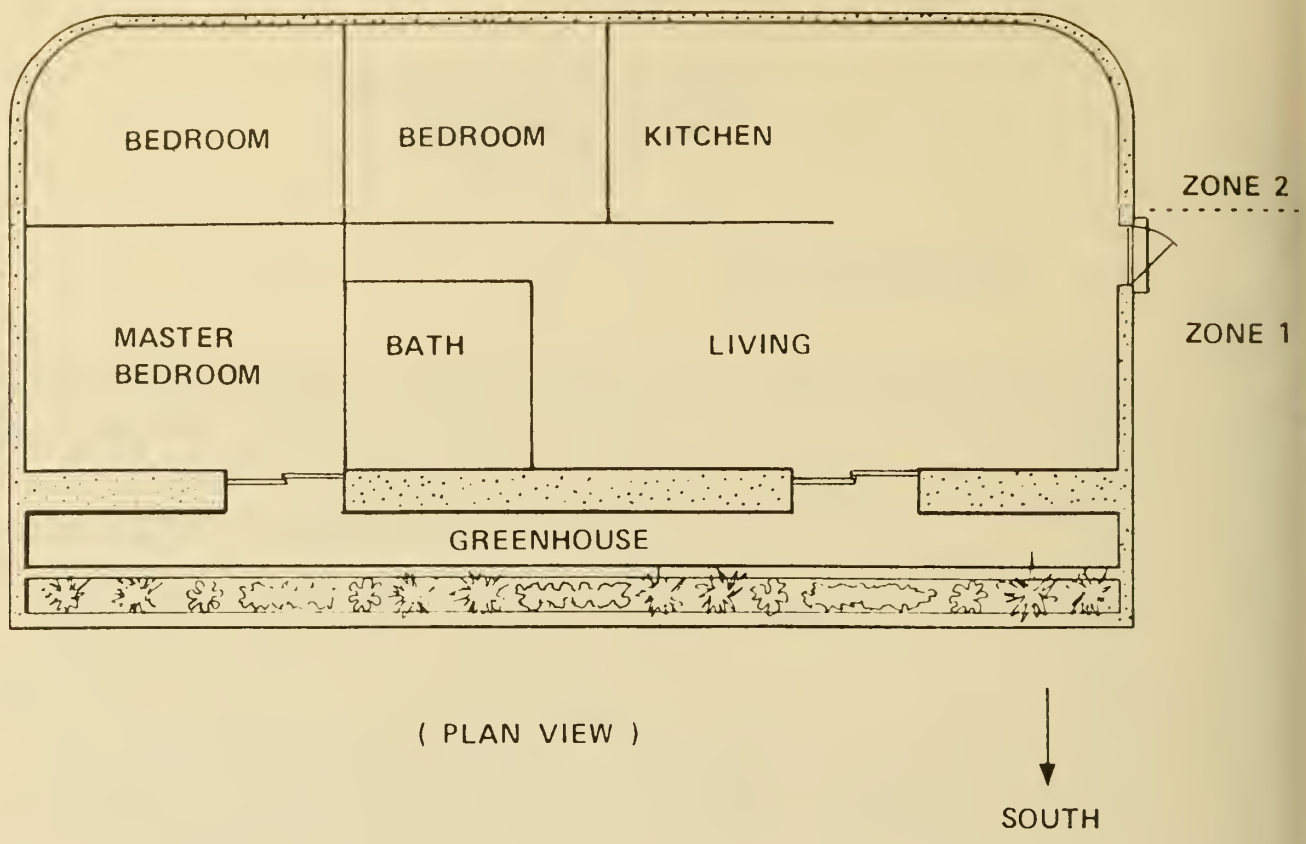
MONTHLY PERFORMANCE REPORT
HULLCO CONSTRUCTION
APRIL 1979

I. SYSTEM DESCRIPTION

The Hullco Construction solar energy system is a passive space heating system for a single family residence located in Prescott, Arizona. The south-facing building, illustrated in the drawings of Figure 1, is a combination greenhouse and direct gain passive system. Incident solar energy enters the building through approximately 400 square feet of double-glazed prefabricated Kalwall panels. Two sliding glass doors between the greenhouse and the house along with a window in the bathroom admit incident solar energy directly into the master bedroom, living room and bath areas of the house. Collected solar energy not used to satisfy the immediate building space heating demand is stored directly in the massive walls and floors of the building or indirectly in the 670 cubic feet of 3 to 5 inch diameter rock storage which is located under the floor of the north half of the building. Stored energy is released by low-temperature radiation to satisfy the building space heating demand during periods of time when incident solar energy is not available.

Direct storage of collected solar energy is provided by the walls and floor of the building. The brick floor and the black painted north wall of the greenhouse provide solar energy storage for the greenhouse. The 12-inch thick, sand-filled concrete block greenhouse north wall acts as a Trombe wall, storing collected energy from the greenhouse during the day, and releasing the collected energy by radiation to the south part of the building at night. The 4-inch thick building concrete slab floor acts as direct solar storage, particularly in the living room and master bedroom areas where the floor is covered with Mexican tile masonary. Additional storage is provided by the 8-inch thick solid grouted concrete exterior insulated building walls on the north, east, and west perimeter of the building.



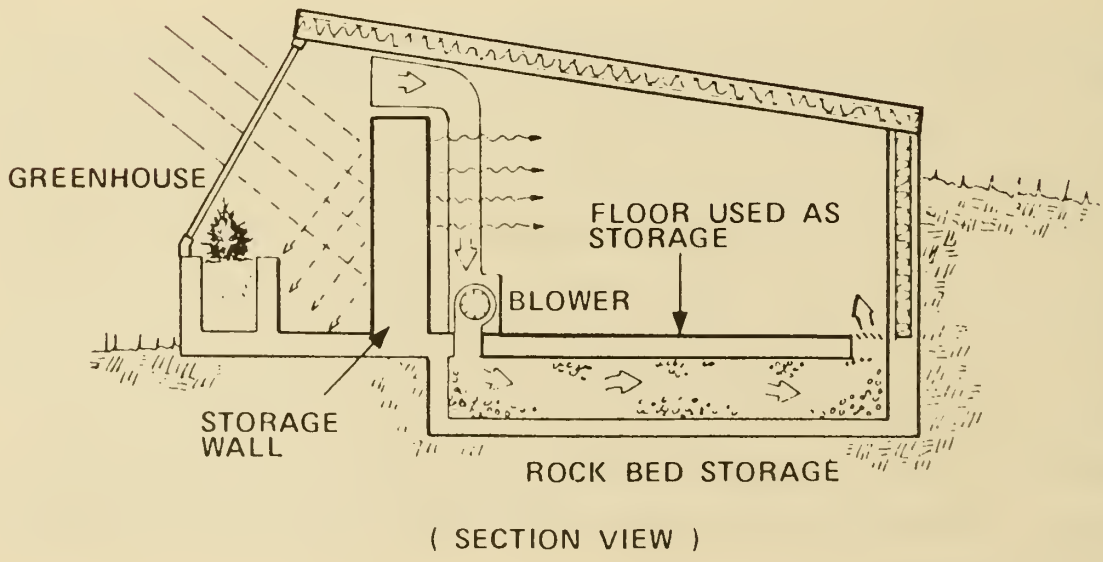


Figure 1. HULCO CONSTRUCTION COMPANY SOLAR ENERGY SYSTEM SCHEMATIC

Indirect storage of collected solar energy is provided by the 670 cubic feet of rock storage located under the north side of the building and by the 4-inch thick carpeted concrete slab floor poured on top of the rock. Solar energy collected in the greenhouse is transferred to the rock bed from vents at the end of the greenhouse through under-floor ducts by two one-third horsepower blowers located at the east and west ends of the greenhouse. After transferring energy to the rocks, the air returns to the greenhouse through the house from floor vents located at the north side of the building. The greenhouse fans operate when temperatures near the top of the greenhouse reach approximately 90°F. Energy stored in the rock is released through the carpeted concrete floor to the house.

Summer overheating protection is provided by venting of the greenhouse and by both natural and artificial shading of the greenhouse glazing. Natural shading of the greenhouse is accomplished by the use of an existing tree to the southeast of the structure. However, the tree, a juniper tree, does shade the greenhouse some during mornings even during heating season. Additional greenhouse shading can be provided by a redwood snow fence placed over the glazing. Draperies covering the sliding glass doors on the north wall of the greenhouse can be closed to prevent incident sunlight from entering the building. Nighttime venting of the building can be used to cool the energy storage masses, thus cooling the building during the day as energy generated inside the building is absorbed by the walls and floor. Daytime venting of the greenhouse is accomplished using a thermostatically controlled powered fan, located at the top of the greenhouse, to draw air through the house and out the top of the greenhouse.

Low building heating loads are maintained by the use of good energy conservation construction techniques. The north, east, and west walls are insulated on the outside of the concrete blocks with two inches of styrafoam with a total wall R-value of 11. Nine inches of fiberglass batt insulation is used in the roof to yield a roof R-value of 32. The entire perimeter of the concrete slab floor is insulated. A minimum of

window area is used on the north east and west walls. The building is bermed four feet into the earth on the north and west sides.

Auxiliary energy for space heating can be supplied by either electric radiant heat panels, or by the wood-burning stove. The wood-burning stove uses outside combustion air. The ceiling-mounted electric radiant heat panels, located in each room, are controlled by individual room thermostats.

The predicted annual solar contribution to the building load is 80 percent. Design monthly building heating loads for the entire area, including the greenhouse, are approximately 11,000 Btu per heating degree-day.

II. PERFORMANCE EVALUATION

A. Introduction

During April, the passive solar energy system at the Hullco Construction site satisfied almost 100 percent of the space heating energy demand. Operation of the wood-burning stove during part of the month and the energy generated inside the house by people, lights and appliances satisfied the remainder of the building load. Weather conditions were near the long-term average weather conditions for the Prescott area during April. Variations in building temperature were generally small during each day, indicating the presence of substantial amounts of energy storage capacity. Comfort levels remained reasonable throughout most of the month. Savings of electrical energy were substantial, even as compared to a similar building with a conventional south wall.

B. Weather

The average incident solar energy on the greenhouse glazing was 1,958 Btu/ft^2-day, which was somewhat above the long-term average of 1,729 Btu/ft^2-day derived from measurements at the Phoenix, Arizona weather

bureau. The average outside ambient temperature for April was 51°F, very near to the long-term April average outside ambient temperature for Prescott of 52°F.

C. System Thermal Performance

Of the 23.5 million Btu incident on the greenhouse glazing, approximately 6.67 million Btu were collected, resulting in a monthly collection efficiency of 28 percent. It should be noted that this collection efficiency does not include energy losses through the glazing. The glazing losses are included as a part of the building load. The collection efficiency is lower than would be expected for April due to the intentional venting of the building which occurred during several of the warmer days of the month and the shading effects of the redwood snow fence. The collected solar energy, along with 0.001 million Btu of auxiliary electric fuel satisfied the space heating demand of 6.43 million Btu. Electrical energy used for operation of the greenhouse fans was 0.13 million Btu. The remainder of the collected solar energy was used to increase the net energy level of the storage masses at the end of the month by 0.23 million Btu.

On a few days early in the month, the wood-burning stove was used to satisfy a measurable amount of the building load. The thermal energy derived from operation of the wood-burning stove is applied as a reduction to the building load. That is, the difference between the building load and the space heating subsystem demand is the energy derived from operating the wood stove. During April, this renewable energy was approximately 0.20 million Btu.

The predicted building load for April was 4.54 million Btu. The actual building load (the sum of the heating demand, greenhouse fan power, and wood-stove energy) was 6.63 million Btu, considerably higher than the design prediction. The majority of this difference is accounted for by warmer than design interior temperature during April. The remainder of the difference is due to an increase in infiltration of outside air compared to the design infiltration rate, due to slightly open windows.

The collected solar energy, 6.67 million Btu, would have been sufficient to satisfy 100 percent of the design building load of 4.54 million Btu for April. However, due to the warmer interior temperatures and consequent larger than expected building load, the collected solar energy was able to satisfy only 97 percent of the building load. It should be noted that the reported parameter, LOAD, is actually a heating demand and is determined as the difference between the building load and other energy sources inside the house (i.e., the wood stove).

The system thermal storage masses provided both adequate thermal reserves and reasonable damping of daily building temperature variations during April. Daily variations in minimum/maximum building temperature averaged 6°F for the month, with a maximum variation of 8°F occurring on several days. Minimum building temperatures generally occur near sunrise and maximum building temperatures near sunset. Consequently, the building temperatures recorded at 6:00 a.m. and 6:00 p.m. are quite close to the daily minimum and maximum building temperatures. The average minimum daily building temperature was 70°F while the average maximum daily building temperature was 76°F.

Computed comfort levels inside the building were reasonable during most of the month in both zones of the building. The comfort level in zone 2 was slightly lower than that of zone 1 due to the distance between zone 2 and the primary collection and storage area of the south wall. The actual comfort level experienced by the occupants was higher than the level reported due to the humidity level inside. The interior relative humidity was relatively high (over 50 percent) for the entire month.

D. Observations

As in past months, the rock storage area under the north side of the building appeared to provide little benefit to the building. The average temperature of the rock was generally 5 to 10°F less than the zone 2 building temperature. Only the top of the rock was near the temperature of the building. This was due to energy transferred from the building to the rock through the concrete slab floor.

The report parameter "ECSS Solar Conversion Efficiency" shown on the summary page of the attached computer printout is defined as the ratio of the solar energy used by the system to the total incident solar energy. As such, it represents an efficiency indication of the use of solar energy by the system. The value printed in this report, 27 percent, is computed with respect to the building use of solar energy. Since part of the solar energy used by the building is used to replace energy losses through the glazed area of the greenhouse, then this parameter would be expected to have a higher value than for an active solar energy system, or a higher value as compared to a building of more conventional construction.

During April, the occupant began a transition to summer operating modes. The redwood snow fence was placed over the greenhouse glazing in a manner such that approximately 25 percent shading was accomplished. Near the end of the month, increased venting of the building was noted as the occupants began to prepare for the summer cooling season.

E. Energy Savings

The building energy savings for April at the Hullco Construction site were an estimated 6.3 million Btu (1,846 kwh) of electrical power. When compared to a conventional building with similar energy conservation features, these building savings are reduced to a comparison savings of 3.6 million Btu (1,063 kwh). As compared to a comparison building where variations in building temperature were more tightly controlled, the comparison savings become the comparison set point savings of 1.3 million Btu (383 kwh). The large difference between the comparison savings and the comparison set point savings is due to the warmer building temperatures encountered. Energy savings for all three cases have been reduced by the power consumed by operation of the greenhouse fans.

For a building where the glazing is an integral part of the building (in a direct gain system), the comparison savings most adequately describe the energy savings realized. However, as the glazing and are of collection become more isolated from the living space, the building savings become more

meaningful. A greenhouse system is in between; that is, it is a livable part of the building when greenhouse temperatures are high, but less usable when temperatures are lower. Consequently, both the building savings and the comparison savings have periods of applicability for the greenhouse system. No attempt is made in this report to quantify the energy savings resulting from the application of energy conserving construction techniques. That is, the energy savings presented in the report are savings resulting only from the use of the incident solar energy.

III. ACTION STATUS

One air flow sensor remains inoperative, but the missing data does not alter computed system performance. The instrumentation of the wood stove operation is being changed from a thermal switch to a stove surface temperature measurement in order to quantify both the heating rate of the wood stove and the effect of the stove on comfort.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: HULLCO
REPORT PERIOD: APRIL,1979

SOLAR/1043-79/04

SITE/SYSTEM DESCRIPTION:
THE HULLCO SITE IS A PASSIVELY HEATED SINGLE FAMILY DWELLING WITH 1056 SQ. FT. OF FLOOR SPACE. THE STRUCTURAL ENVELOPE OPENS TO THE SOUTH WHERE A GREENHOUSE TRAPS HEAT. HEAT LOSSES FROM THE HOUSE ARE REDUCED BY USING HEAVY INSULATION IN THE CEILING AND REDUCING GLASS AREAS ON NORTH, EAST, AND WEST FACADES. ENERGY IS STORED IN THE CONCRETE FLOOR OF THE HOUSE AND THE MASSIVE INTERNAL WALLS. ADDITIONAL STORAGE IS PROVIDED BY TWO ROCK BEDS UNDER THE NORTH END OF THE BUILDING CHARGED BY FORCED AIR FROM THE GREENHOUSE.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	23.494 MILLION BTU
	58734 BTU/SQ.FT.
COLLECTED SOLAR ENERGY	6.667 MILLION BTU
	16567 BTU/SQ.FT.
AVERAGE AMBIENT TEMPERATURE	51 DEGREES F
AVERAGE BUILDING TEMPERATURE	72 DEGREES F
ECSS SOLAR CONVERSION EFFICIENCY	0.27
ECSS OPERATING ENERGY	0.130 MILLION BTU
TOTAL SYSTEM OPERATING ENERGY	0.130 MILLION BTU
TOTAL ENERGY CONSUMED	6.563 MILLION BTU

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	N.A.	6.432	N.A.	6.432 MILLION BTU
SOLAR FRACTION	N.A.	100	N.A.	100 PERCENT
SOLAR ENERGY USED	N.A.	6.432	N.A.	6.432 MILLION BTU
OPERATING ENERGY	N.A.	0.130	N.A.	0.130 MILLION BTU
AUX. THERMAL ENERGY	N.A.	0.001	N.A.	0.001 MILLION BTU
AUX. ELECTRIC FUEL	N.A.	0.001	N.A.	0.001 MILLION BTU
AUX. FOSSIL FUEL	N.A.	N.A.	N.A.	N.A. MILLION BTU
ELECTRICAL SAVINGS	N.A.	6.302	N.A.	6.302 MILLION BTU
FOSSIL SAVINGS	N.A.	N.A.	N.A.	N.A. MILLION BTU

SYSTEM PERFORMANCE FACTOR: 14.834

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM, FEBRUARY 28,1978, SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: HULLCO
REPORT PERIOD: APRIL,1979

SOLAR/1043-79/04

SITE/SYSTEM DESCRIPTION:
THE HULLCO SITE IS A PASSIVELY HEATED SINGLE FAMILY DWELLING WITH 1056 SQ. FT. OF FLOOR SPACE. THE STRUCTURAL ENVELOPE OPENS TO THE SOUTH WHERE A GREENHOUSE TRAPS HEAT. HEAT LOSSES FROM THE HOUSE ARE REDUCED BY USING HEAVY INSULATION IN THE CEILING AND REDUCING GLASS AREAS ON NORTH, EAST, AND WEST FACADES. ENERGY IS STORED IN THE CONCRETE FLOOR OF THE HOUSE AND THE MASSIVE INTERNAL WALLS. ADDITIONAL STORAGE IS PROVIDED BY TWO ROCK BEDS UNDER THE NORTH END OF THE BUILDING CHARGED BY FORCED AIR FROM THE GREENHOUSE.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	24.786 GIGA JOULES
	666987 KJ/SQ.M.
COLLECTED SOLAR ENERGY	7.034 GIGA JOULES
	189271 KJ/SQ.M.
AVERAGE AMBIENT TEMPERATURE	10 DEGREES C
AVERAGE BUILDING TEMPERATURE	22 DEGREES C
ECSS SOLAR CONVERSION EFFICIENCY	0.27
ECSS OPERATING ENERGY	0.137 GIGA JOULES
TOTAL SYSTEM OPERATING ENERGY	0.137 GIGA JOULES
TOTAL ENERGY CONSUMED	6.924 GIGA JOULES

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	N.A.	6.786	N.A.	6.786 GIGA JOULES
SOLAR FRACTION	N.A.	100	N.A.	100 PERCENT
SOLAR ENERGY USED	N.A.	6.786	N.A.	6.786 GIGA JOULES
OPERATING ENERGY	N.A.	0.137	N.A.	0.137 GIGA JOULES
AUX. THERMAL ENG	N.A.	0.001	N.A.	0.001 GIGA JOULES
AUX. ELECTRIC FUEL	N.A.	0.001	N.A.	0.001 GIGA JOULES
AUX. FOSSIL FUEL	N.A.	N.A.	N.A.	N.A. GIGA JOULES
ELECTRICAL SAVINGS	N.A.	6.649	N.A.	6.649 GIGA JOULES
FOSSIL SAVINGS	N.A.	N.A.	N.A.	N.A. GIGA JOULES

SYSTEM PERFORMANCE FACTOR: 14.834

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM,FEBRUARY 28,1978, SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SPACE HEATING SUBSYSTEM

SITE: HULLCO
REPORT PERIOD: APRIL, 1979

SO_AR/1043-79/04

DAY OF MON.	SPACE HEATING LOAD MILLION BTU	SOLAR FR.OF LOAD PCT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	BLDG TEMP DEG. F	AMB TEMP DEG. F
1	0.354	100	0.354	0.004	0.000	0.000	N	0.350	N	71	40
2	0.328	100	0.328	0.000	0.000	0.000	O	0.327	O	70	36
3	0.332	100	0.332	0.003	0.000	0.000	T	0.329	T	72	40
4	0.314	100	0.314	0.005	0.000	0.000		0.309		72	42
5	0.242	100	0.242	0.008	0.000	0.000	A	0.234	A	72	49
6	0.192	100	0.192	0.008	0.000	0.000	P	0.185	P	73	51
7	0.193	100	0.193	0.005	0.000	0.000	P	0.188	P	73	52
8	0.212	100	0.212	0.001	0.000	0.000	L	0.211	L	72	51
9	0.222	100	0.221	0.000	0.001	0.001	I	0.221	I	73	50
10	0.297	100	0.297	0.000	0.000	0.000	C	0.297	C	72	38
11	0.367	100	0.367	0.001	0.000	0.000	A	0.366	A	71	41
12	0.289	100	0.289	0.003	0.000	0.000	B	0.286	B	72	46
13	0.244	100	0.244	0.005	0.000	0.000	L	0.238	L	73	49
14	0.174	100	0.174	0.009	0.000	0.000	E	0.165	E	72	54
15	0.161	100	0.161	0.009	0.000	0.000		0.153		73	55
16	0.142	100	0.142	0.007	0.000	0.000		0.135		72	56
17	0.178	100	0.178	0.000	0.000	0.000		0.178		73	57
18	0.250	100	0.250	0.000	0.000	0.000		0.250		73	50
19	0.315	100	0.315	0.000	0.000	0.000		0.315		74	45
20	0.227	100	0.227	0.000	0.000	0.000		0.227		74	51
21	0.171	100	0.171	0.008	0.000	0.000		0.164		72	52
22	0.124	100	0.124	0.008	0.000	0.000		0.116		71	55
23	0.207	100	0.207	0.000	0.000	0.000		0.207		73	57
24	0.131	100	0.131	0.002	0.000	0.000		0.129		73	57
25	0.103	100	0.103	0.011	0.000	0.000		0.093		71	58
26	0.170	100	0.170	0.000	0.000	0.000		0.170		74	59
27	0.153	100	0.153	0.000	0.000	0.000		0.153		74	58
28	0.108	100	0.108	0.012	0.000	0.000		0.096		72	57
29	0.110	100	0.110	0.011	0.000	0.000		0.099		72	59
30	0.120	100	0.120	0.009	0.000	0.000		0.112		72	59
SUM	6.432	-	6.432	0.130	0.001	0.001	N.A.	6.302	N.A.	-	-
AVG	0.214	100	0.214	0.004	0.000	0.000	N.A.	0.210	N.A.	72	51
NBS	Q402	N400	Q400	Q403	Q401		Q410	Q415	Q417	N406	N113

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENVIRONMENTAL SUMMARY

SITE: HULLCO
REPORT PERIOD: APRIL,1979

SOLAR/1043-79/04

DAY OF MONTH	TOTAL INSOLATION BTU/SQ.FT	DIFFUSE INSOLATION BTU/SQ.FT	AMBIENT TEMPERATUPE DEG F	DAYTIME AMBIENT TEMP DEG F	RELATIVE HUMIDITY PERCENT	WIND DIRECTION DEGREES	WIND SPEED M.P.H.
1	2090	N	40	51	45	173	3
2	1259	O	36	45	52	201	3
3	2239	T	40	48	54	142	2
4	2226		42	55	48	0	2
5	2181	A	49	67	46	0	2
6	2210	P	51	67	36	268	5
7	2173	P	52	67	33	260	3
8	1532	L	51	66	40	*	2
9	1508	I	50	60	46	264	7
10	1383	C	38	42	41	203	7
11	2114	A	41	51	28	231	5
12	2109	B	46	56	34	141	4
13	2109	L	49	65	38	0	2
14	2099	E	54	73	39	289	2
15	2099		55	73	35	272	3
16	2096		56	73	29	271	4
17	2116		57	67	14	277	8
18	2061		50	59	28	272	7
19	2066		45	59	28	0	1
20	1979		51	70	28	0	2
21	2027		52	72	26	237	2
22	2025		55	72	20	267	4
23	1950		57	70	21	258	6
24	1740		57	69	18	256	5
25	1932		58	72	24	243	4
26	1547		59	72	30	234	4
27	2007		58	72	35	235	4
28	1924		57	73	30	227	2
29	1910		59	76	21	231	2
30	1922		59	72	20	273	4
SUM	58734	N.A.	-	-	-	-	-
AVG	1958	N.A.	51	64	33	252	4
NBS ID	Q001		N113			N115	N114

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
PASSIVE SPACE HEATING

SITE: HULLCO
REPORT PERIOD: APRIL,1979

SOLAR/1043-79/04

DAY OF MON	SPACE HEATING LOAD MILLION BTU	SOLAR ENERGY USED MILLION BTU	CHANGE IN STORE ENERGY MILLION BTU	AVERAGE STORAGE TEMP DEG F	DIRECT SOLAR JTIL EFFIC	AUX THERMAL USED MILLION BTU	BLDG TEMP DEG F	AMB TEMP DEG F	WIND AVG SPEED MPH	WIND AVG DIR DEG	SOLAR LOAD PER CENT
1	0.354	0.354	0.022	70.0	0.424	0.000	71	40	2.9	173	100
2	0.327	0.327	-0.083	68.7	0.651	0.000	70	36	2.8	201	100
3	0.332	0.332	0.073	69.5	0.371	0.000	72	40	2.4	142	100
4	0.314	0.314	0.042	70.2	0.353	0.000	72	42	1.6	0	100
5	0.241	0.241	0.080	71.1	0.277	0.000	72	49	1.6	0	100
6	0.192	0.192	0.050	71.9	0.218	0.000	73	51	4.8	268	100
7	0.193	0.193	-0.052	72.0	0.223	0.000	73	52	3.3	260	100
8	0.212	0.212	-0.062	70.8	0.346	0.000	72	51	2.4	*	100
9	0.221	0.221	-0.053	70.1	0.367	0.000	73	50	6.6	264	100
10	0.297	0.297	-0.065	69.0	0.537	0.000	72	38	7.2	203	100
11	0.367	0.367	0.033	68.8	0.434	0.000	71	41	5.5	231	100
12	0.289	0.289	0.069	70.0	0.343	0.000	72	46	4.0	141	100
13	0.243	0.243	0.079	71.0	0.289	0.000	73	49	1.6	0	100
14	0.174	0.174	0.046	71.7	0.208	0.000	72	54	2.1	289	100
15	0.161	0.161	-0.017	71.2	0.192	0.000	73	55	2.6	272	100
16	0.141	0.141	-0.014	70.9	0.169	0.000	72	56	3.7	271	100
17	0.177	0.177	-0.041	70.7	0.210	0.000	73	57	7.8	277	100
18	0.249	0.249	-0.043	70.2	0.303	0.000	73	50	7.3	272	100
19	0.315	0.315	0.001	69.8	0.382	0.000	74	45	1.4	0	100
20	0.227	0.227	-0.004	69.9	0.287	0.000	74	51	1.9	0	100
21	0.171	0.171	0.090	69.9	0.211	0.000	72	52	2.2	237	100
22	0.124	0.124	-0.003	70.4	0.153	0.000	71	55	4.1	267	100
23	0.207	0.207	0.001	70.5	0.265	0.000	73	57	5.8	258	100
24	0.130	0.130	0.003	70.7	0.188	0.000	73	57	5.0	256	100
25	0.103	0.103	0.024	70.8	0.134	0.000	71	58	3.5	243	100
26	0.169	0.169	-0.003	70.7	0.258	0.000	74	59	4.1	234	100
27	0.153	0.153	-0.007	71.0	0.191	0.000	74	58	4.1	235	100
28	0.108	0.108	0.049	71.1	0.141	0.000	72	57	2.3	227	100
29	0.109	0.109	0.032	71.4	0.143	0.000	72	59	2.4	231	100
30	0.120	0.120	-0.013	71.6	0.156	0.000	72	59	4.0	273	100
SUM	6.432	6.431	0.234	-	-	0.000	-	-	-	-	-
AVG	0.214	0.214	0.007	70.5	0.274	0.000	72	51	3.7	252	100
NBS	Q402	Q400	Q202			Q401	N405	N113	N114	N115	N400

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
PASSIVE SYSTEM ENVIRONMENT

SITE: HULLCO
REPORT PERIOD: APRIL,1979

SOLAR/1043-79/04

DAY OF MON	BUILDING COMFORT ZONE 1	BLDG COMF ZONE 2	BUILDING TEMP MIDNIGHT DEG F	BUILDING TEMP 6 AM DEG F	BUILDING TEMP NOON DEG F	BUILDING TEMP 6 PM DEG F	INTERIOR RELATIVE HUMIDITY PERCENT	AMB TEMP DEG F	DAYTIME AMB TEMP DEG F	INCIDENT SOLAR ENERGY MILLION BTJ	AVG STOR TEMP DEG F
1	73	68	70	68	72	78	58	40	51	0.836	70
2	72	68	71	69	69	70	56	36	45	0.504	69
3	74	70	73	70	72	75	53	40	48	0.896	69
4	74	69	72	69	71	75	54	42	55	0.890	70
5	74	70	72	70	71	76	57	49	67	0.872	71
6	75	70	73	70	74	77	57	51	67	0.884	72
7	74	70	73	71	73	74	50	52	67	0.869	72
8	74	70	72	70	73	75	47	51	56	0.613	71
9	74	70	73	71	73	75	44	50	60	0.603	70
10	74	70	75	71	73	72	46	38	42	0.553	69
11	73	68	70	68	72	74	50	41	51	0.845	69
12	74	70	72	69	73	76	54	46	56	0.844	70
13	74	70	73	70	73	77	58	49	65	0.843	71
14	74	70	73	70	73	74	55	54	73	0.840	72
15	74	70	73	71	69	76	57	55	73	0.839	71
16	74	70	73	71	75	72	58	56	73	0.839	71
17	74	71	73	71	74	75	55	57	67	0.845	71
18	74	71	73	72	73	75	54	50	59	0.824	70
19	74	72	73	71	73	77	58	45	59	0.826	70
20	75	72	74	71	74	76	59	51	70	0.792	70
21	74	70	73	71	74	73	56	52	72	0.811	70
22	72	69	73	70	69	71	55	55	72	0.810	70
23	74	71	71	70	73	77	58	57	70	0.780	71
24	74	71	74	72	74	75	59	57	69	0.696	71
25	73	69	73	71	69	72	59	58	72	0.773	71
26	74	72	72	71	73	77	60	59	72	0.659	71
27	75	72	*	72	74	76	58	58	72	0.803	71
28	73	70	75	72	71	71	57	57	73	0.769	71
29	73	70	73	71	70	74	56	59	76	0.764	71
30	74	70	73	72	74	72	57	59	72	0.769	72
SUM	-	-	-	-	-	-	-	-	-	23.494	-
AVG	74	70	73	70	72	75	55	51	64	0.783	71
NBS								N113			

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
HULLCO SITE SPECIAL REPORT

SITE: HULLCO
SOLAR/1043-79/04
REPORT PERIOD: APRIL,1979

DAY OF MON	STORAGE AVG TEMP DEG F	ROCK STOR AVG TEMP DEG F	TROMBE WALL AVG TEMP DEG F	DIRECT GAIN FLOOR AVG TEMP DEG F
1	70	63	77	72
2	69	63	74	71
3	69	62	76	72
4	70	63	77	73
5	71	64	78	73
6	72	66	79	73
7	72	66	79	74
8	71	65	77	73
9	70	64	76	73
10	69	63	74	72
11	69	63	74	72
12	70	63	77	73
13	71	64	78	73
14	72	66	78	74
15	71	67	76	73
16	71	67	75	73
17	71	66	76	72
18	70	65	75	72
19	70	65	75	72
20	70	64	75	72
21	70	65	75	72
22	70	67	74	72
23	71	67	75	72
24	71	67	75	72
25	71	68	75	72
26	71	68	75	72
27	71	68	75	72
28	71	68	75	72
29	71	69	75	72
30	72	70	75	72
SUM	-	-	-	-
AVG	71	65	76	72
NBS				

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